METHOD OF CONTROLLING COMMUNICATION CHANNELS AND BASE STATION AND TERMINAL IMPLEMENTING THE METHOD

5   The present invention relates to the control of communication channels in a communication system comprising a base station and several terminals. It has a particular, non-exclusive, application in cellular networks for radio communication with mobiles.

10   In communication systems, it is conventional to manage the allocation of channels by way of a control facility. The latter is in fact furnished with a set of communication resources that it can distribute at its convenience, for example upon a traffic channel request
15   by a user.

The control facility therefore makes communication channels available to a base station so that the latter can communicate with terminals under its zone of
20   coverage. The control facility and the terminal converse according to a resource management protocol, transparent to the base station, in particular so that the terminal is informed of the channels to be used, in the form of a subset of the communication channels
25   allocated to the base station.

Such management of the communication channels exhibits some rigidity since it necessitates systematic intervention from the control facility in case of
30   reallocation of the communication channels, if for example one wishes to use, for a terminal, channels that have not been assigned to it specifically at the start of its communication session with a base station. Now, there are various circumstances where a
35   reassignment of resources may seem to be desirable at the base station level without it being opportune to advise the control facility thereof, for example for reasons of management of the hardware and/or software resources within the base station or else because the

delay occasioned by the exchange with the control facility is not acceptable having regard to the characteristics of the service.

5   In certain cases, the control facility allocates the base station a set of channels without signaling them especially to the terminal. When the base station needs to communicate with the terminal, it selects one of these channels and indicates it to the terminal, for
10   example on one or more associated signaling channels. Such a procedure is well suited to the implementation of fast communication services over traffic channels shared between several terminals. The associated signaling channels are also shared channels. The
15   terminal must then know the associated signaling channel or channels that it may have to listen to. If these channels are assigned to it by the control facility, the above problem arises again each time the need appears, at the base station level, to reassign
20   the shared signaling channels used for a given terminal.

Another possibility of letting the terminal know the shared channel or channels to be used consists of a
25   fast signaling mechanism, for example one using symbol stealing, over a dedicated communication channel set up with the terminal. However, this may result in an undesirable reduction in the bandwidth afforded by this dedicated channel, in particular if the list of
30   possible channels is relatively extensive or unknown a priori to the terminal.

An object of the present invention is to improve the flexibility of these methods of managing shared
35   communication channels.

The invention thus proposes a method of controlling communication channels between a base station and terminals, including channels that are shared by the

terminals so as to communicate with said base station
and at least one channel of the base station that is
dedicated to one of the terminals. The method comprises
the following steps:

5   -   allocating a list of shared channels, which list
          is composed of several sets of shared channels, to
          the base station;

     -    for a communication session between the base
          station and said terminal, indicating to the
10   terminal, from a control facility, the list of
          shared channels that is allocated to the base
          station; and

     -    at the base station level, selecting for the
          terminal one of the sets of shared channels and,
15   independently of the control facility, indicating
          the selected set to the terminal by way of said
          dedicated channel.

     A dynamic choice of the channels to be used for a
20   terminal is therefore made in a quasi-autonomous manner
     by the base station without intervention from the
     control facility. To make this choice, the base station
     is not constrained by an assignment of channels that
     would have been performed specially for the terminal.
25   This results in greater flexibility in the management
     of the shared channels, which allows optimal use of the
     available resources.

     The control facility merely signals to the terminal the
30   list allocated to the base station, when setting up the
     communication session or during a reconfiguration of
     this session. It does not have to intervene when the
     base station dynamically modifies its selection from
     the list which was allocated to it.

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     The choice of the communication channels to be used by
     the terminal can depend on a shareout of processing
     resources in the base station. In particular, if the
     base station possesses a modular architecture, each set

of communication channels allocated to a terminal can be processed by a given module.

The shared communication channels may be signaling channels or traffic channels. In the case of signaling channels, they can contain information allowing a terminal to read a shared traffic channel.

The indication of the communication channels to be used by the terminal can advantageously be transmitted to it by inserting this item of information into the data stream dispatched to it over a dedicated communication channel. This insertion can be carried out by stealing symbols from the stream sent. In this way, the transmission of the information does not require the introduction of new communication resources specific to this use.

In the case where one wishes to transmit this item of information with low periodicity, and possibly with some redundancy, so as to increase the reliability of its receipt by the terminal, care must be taken that the stealing of symbols does not turn out to be detrimental to the decoding performance in respect of the information received on account of an interleaving of the data transmitted. It is therefore possible to vary the position of the stolen symbols so as to avoid clusters of symbols empty of information during the decoding performed by the terminal.

If another item of information, such as an indication of a channel from among the set selected that the terminal must decode, forms the subject of a stealing of symbols on the dedicated channel, the position of the symbols stolen to indicate the selected set to the terminal, must preferably be effected aptly with this other stealing of symbols.

The invention also proposes a base station for a system
for communicating with terminals, comprising:

- means for obtaining, in conjunction with a control
  facility, a list of shared channels that is
5 allocated to the base station and is composed of
  several sets of shared channels;
- means for selecting, for one of the terminals, one
  of the sets of shared channels; and
- means for indicating to said terminal by way of a
10 dedicated channel, independently of the control
  facility, which set is selected from the list
  allocated to the base station.

Finally, the invention proposes a terminal for a
15 communication system comprising at least one base
station and a control facility and using channels
shared with other terminals to communicate with the
base station and at least one dedicated channel from
the base station to said terminal. This terminal
20 according to the invention comprises:

- means for receiving from the control facility a
  list of shared channels that is allocated to the
  base station, and is composed of several sets of
  shared channels, for a communication session with
25 the base station; and
- means for receiving from the base station, by way
  of said dedicated channel, an indication of one of
  the sets of shared channels that is selected by
  the base station for said terminal.
30

Other features and advantages of the present invention
will become apparent in the description hereinbelow of
nonlimiting exemplary embodiments, with reference to
the appended drawings, in which:
35 - figure 1 is a diagram illustrating the frame
  structure employed on the downlinks in the UMTS
  system in FDD mode;
- figures 2 and 3 are schematic diagrams of a base
  station and of a UMTS terminal;

- figures 4 and 5 are schematic diagrams of the multiplexing and demultiplexing blocks of the base station and of the terminal according to figures 2 and 3;

5 - figure 6 is a simplified diagram indicating the manner of operation of the first interleaver in a UMTS radio network;

- figure 7 is a simplified diagram indicating the manner of operation of the second interleaver in a 10 UMTS radio network;

- figure 8 is a diagrammatic representation of a base station with modular architecture; and

- figure 9 is an example of symbol stealing implemented in an embodiment of the invention.

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In the present description, the invention will be described more particularly in its nonlimiting application to third-generation radio communication networks of the UMTS type ("Universal Mobile 20 Telecommunication System") in FDD ("Frequency Division Duplex") mode.

UMTS is a radio communication system using Code-Division Multiple Access (CDMA), that is to say the 25 symbols transmitted are multiplied by spreading codes consisting of samples known as "chips" whose rate (3.84 Mchip/s in the case of UMTS) is greater than that of the symbols transmitted. The spreading codes distinguish between various physical channels PhCH 30 which are superimposed on the same transmission resource constituted by carrier frequency. The auto- and cross-correlation properties of the spreading codes enable the receiver to separate the PhCHs and to extract the symbols intended for it. For UMTS in FDD 35 mode on the downlink, a scrambling code is allocated to each base station, and various physical channels used by this base station are distinguished by mutually orthogonal "channelization" codes. For each PhCH, the global spreading code is the product of the

"channelization" code and the scrambling code of the base station. The spreading factor (equal to the ratio of the chip rate to the symbol rate) is a power of 2 lying between 4 and 512. This factor is chosen as a
5   function of the bit rate of the symbols to be transmitted on the PhCH.

The various physical channels obey a frame structure illustrated in Figure 1. The 10 ms frames follow one
10   another on the carrier frequency used by the base station. Each frame is subdivided into N = 15 time slots of 666 μs. Each slot can carry the superimposed contributions of one or more physical channels, comprising common channels and dedicated channels DPCH
15   ("Dedicated Physical CHannel"). The lower chart of figure 1 illustrates the contribution of a downlink DPCH at a time slot in FDD mode, which comprises:
          -   a certain number of pilot symbols PL. Known a
              priori to the terminal, these symbols PL enable
20   it to acquire the synchronization and to
              estimate parameters which are useful in
              demodulating the signal;
          -   a Transport Format Combination Indicator TFCI;
          -   a Transmit Power Control TPC to be used by the
25   terminal on the uplink; and
          -   two data fields, denoted DATA1 and DATA2,
              placed either side of the TPC field.
              The DPCH can thus be seen as amalgamating a
physical channel dedicated to control, or DPCCH
30   ("Dedicated Physical Control CHannel"), corresponding to the fields TFCI, TPC and PL, and a physical channel dedicated to the data, or DPDCH ("Dedicated Physical Data CHannel"), corresponding to the fields DATA1 and DATA2.
35

The modulation used on the DPCH channels is a Quadrature Phase Shift Keying (QPSK) modulation. The symbol sequences submitted to the modulator are

therefore composed of quaternary symbols each consisting of the assemblage of two bits.

For one and the same communication, it is possible to
5 establish several DPCHs corresponding to different "channelization" codes, whose spreading factors may be equal or different. This situation is encountered in particular when a DPDCH is insufficient to provide the transmission bit rate required by the application. In
10 what follows, Y will denote the number, equal to or greater than 1, of downlink physical channels used for one and the same communication from a base station.

Moreover, this same communication can use one or more
15 transport channels TrCH. Multiplexed TrCHs are typically used for multimedia transmissions, in which signals of different natures to be transmitted simultaneously require different transport characteristics, in particular as regards protection
20 against transmission errors. On the other hand, certain coders may output, in order to represent a given signal (audio for example), several streams of symbols having different perceptual importances and therefore requiring different degrees of protection. Multiple
25 TrCHs are then used to transport these various symbol streams. In what follows, X will denote the number, equal to or greater than 1, of transport channels used for a given communication on the aforesaid Y physical channels.
30

For each transport channel i $(1 \leq i \leq X)$, there is defined a transmission time interval TTI composed of F_i consecutive frames, with $F_i = 1, 2, 4$ or 8. Typically, the shorter the delay with which the signal conveyed by
35 the transport channel must be received, the shorter the TTI used. For example, a TTI of 20 ms $(F_i = 2)$ will be used for a telephony application, while a TTI of 80 ms $(F_i = 8)$ may be used for a data transmission application.

The multiplexing of the X streams of information symbols emanating from the TrCHs on the Y PhCHs is described in detail in the technical specification 3G TS 25.212, "Multiplexing and channel coding (FDD), Release 1999", version 3.7.0 published in September 2001 by the 3GPP (3rd Generation Partnership Project).

Figure 2 diagrammatically illustrates the sending part of a UMTS base station operating in FDD mode. Block 1 denotes the set of sources 81 respectively outputting streams of information symbols a_i ($1 \leq i \leq X$) in relation to the X TrCHs used in a communication on dedicated resources between the base station and a terminal.

Block 2 multiplexes the streams a_i to form what is referred to as a Coded Composite Transport Channel, or CCTrCH, which is subsequently subdivided into one or more physical channels PhCH#j ($1 \leq j \leq Y$) on which synchronized streams of symbols respectively denoted r_j are transmitted.

Block 3 designates the circuits which modulate the streams r_j and combine them to form a signal processed by the radio stage 4 before being sent over the air interface. Block 3 caters for the spreading, by the "channelization" codes assigned to the PhCHs, of each of the streams r_j (modules 83), as well as of any additional streams which may be output in respect of other communications supported at the same moment by the base station, the various streams of symbols thus spread being subsequently summed and then multiplied by the scrambling code of the base station (module 84). The sequencing and parameterization of blocks 1, 2, 3 is catered for by a control unit 5 in accordance with the parameters defined for the base station and for the communication under consideration.

Figure 3 diagrammatically illustrates the receiving part of a UMTS terminal communicating in FDD mode with a base station according to figure 2. Block 7 comprises modules 91 (matched filters) for despreading the
5 baseband signal restored by the radio stage 6 from the signal picked up by the antenna of the terminal, using the scrambling code of the base station and the respective Y "channelization" codes assigned to the terminal. For each of the Y physical channels j $(1 \leq j$
10 $\leq Y)$, a module 92 demodulates the despread signal so as to deliver respective data r'_j representing estimates of the symbols of the stream r_j formed at base station level.

15 In the case where the symbols are bits, the estimates r'_j are "softbits", that is to say numerical values whose sign characterizes the estimated bit and whose absolute value represents the likelihood of this estimate.
20

The Y data streams r'_j are delivered to a demultiplexing block 8 which performs the operations inverse to those of the multiplexer 2 of the base station. This block 8 outputs for each transport
25 channel i $(1 \leq i \leq X)$ a stream a'_i of estimates (softbits or hardbits) of the symbols of the stream a_i. These estimates a'_i are delivered to the processing circuit of the TrCH i belonging to the block 9. The sequencing and parameterization of blocks 7, 8, 9 is
30 catered for by a control unit 10 of the terminal.

As is usual in the field of digital radiocommunications, the blocks 1-3,5 of the base station and 7-10 of the terminal can be embodied by
35 programming one or more digital signal processors and/or by using specific logic circuits.

Figures 4 and 5 respectively detail the various functional modules of the multiplexing block 2 and

demultiplexing block 8 (see the aforesaid specification
3G TS 25.212). In these figures, the references bearing
the index i (1 ≤ i ≤ X) designate the elements
referring to TrCH i (blocks 20_i and 40_i), the references
5   bearing the index j designating the elements referring
to PhCH j (1 ≤ j ≤ Y), and the references with no index
referring to the operations performed for each frame at
CCTrCH level.

10   The stream a_i to be transmitted on each TRCH i is
composed of binary symbols output in the form of
successive Transport Blocks TrBk. The module 21_i
completes each TrBk by adding thereto a cyclic
redundancy code CRC, serving to detect any transmission
15   errors. The TrBk b_i are then concatenated and/or
segmented by the module 22_i so as to form blocks o_i of
appropriate size for the input of the channel coder
23_i.

20   For each TTI of transport channel i, the channel coder
23_i outputs a sequence c_i of E_i coded bits denoted $c_{i,m}$
(1 ≤ m ≤ E_i). Two types of error correcting code may be
applied by the module 23_i:
- a convolutional code of rate 1/2 or 1/3 and of
25   constraint length K = 9;
- a turbo code of rate 1/3 for the applications
        which require the lowest error rates. In this
        case, the bits $c_{i,3p+q}$ of the output sequence
        from the coder are systematic bits (copies of
30   the input blocks o_i) if q = 1, and parity bits
        if q = 2 or 0.

The bit rate matching modules 24_i delete (puncture) or
repeat bits of the sequences c_i so as to match the bit
35   rate of the TrCHs to the global bit rate allowable on
the PhCH or PhCHs given their spreading factors. For
each TTI on TrCH i, there is defined, from the
information provided by the higher protocol layers, a
parameter ΔN_i^{TTI}, negative in the case of puncturing and

positive in the case of repetition. The sequence g_i produced by the module 24_i for the TTI is composed of $G_i = E_i + \Delta N_i^{TTI}$ bits denoted $g_{i,n}$ $(1 \leq n \leq G_i)$. In the case where the module 23_i has used a turbo code, the puncturing applied by the module 24_i if $\Delta N_i^{TTI} < 0$ is limited to the parity bits, given the greater importance of the systematic bits to the decoder.

In a given frame, the periods devoted to the various TrCHs of the communication may have fixed positions (before the intra-frame interleaving mentioned below) or variable positions. In the case of fixed positions, it may be necessary to append to the sequence g_i, by means of the module 25_i, one or more marked symbols which will not be transmitted (the value of the corresponding bit will for example be set to zero instead of ± 1 in the output stream r_j comprising such a symbol so that the transmission power of the symbol is zero). The DTX ("Discontinuous Transmission") bits thus marked are denoted "δ". In the exemplary implementation considered here in a nonlimiting manner, each symbol $h_{i,n}$ of the sequence h_i output by the module 25_i $(0 \leq n \leq F_i.H_i$, with $G_i \leq F_i.H_i)$ is represented by two bits:

- $h_{i,n} = (0, g_{i,n})$ if $n \leq G_i$;
- $h_{i,n} = (1, 0)$ if $G_i < n \leq F_i.H_i$ (marked bits "δ").

The interleaving module 26_i performs a permutation of the sequence h_i, with a view to distributing the symbols pertaining to the TTI over the F_i frames which it covers. This inter-frame interleaving (if $F_i > 1$) consists in writing the symbols of the sequence h_i successively into the rows of a matrix comprising F_i columns, in permuting the columns of the matrix, and then in reading the symbols of the matrix column by column to form the sequence denoted q_i. The module 27_i then chops the sequence q_i into F_i segments of consecutive symbols corresponding to the F_i columns of the interleaving matrix after permutation, and

respectively assigns these segments to the F_i frames of the TTI to form a sequence denoted f_i for each frame and each TrCH i ($1 \leq i \leq X$).

5   In accordance with the specification 3G TS 25.212, the permutation of columns performed by the inter-frame interleaver 26_i is such that the n-th symbol $h_{i,n}$ of the TTI, with $n = (\alpha - 1) . F_i + \beta$, α and β being integers such that $1 \leq \alpha \leq R1$ and $1 \leq \beta \leq F_i$, is at the α-th

10   position in the γ-th frame of the TTI, i.e.:

$$h_{i,n} = q_{i,n'}$$

with $n' = (\gamma - 1).R1 + \alpha$

where R1 denotes the smallest integer such that $R1 \times F_i$

15   is at least equal to the number X_i of bits of the current frame ($X_i \leq R1 \times F_i$), and γ is a frame index defined by the integer β according to the permutation: $\gamma - 1 = BR(n - 1, F_i) = BR(\beta - 1, F_i)$. The number BR $(x, 2^y)$ is here defined as the integer whose

20   representation to the base 2 corresponds to the reading in the reverse direction of the representation to the base 2 on y digits of the remainder from the Euclidean division of x by 2^y (for example $BR(51, 8) = BR(3, 8) = BR([011]_2, 2^3) = [110]_2 = 6$).

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The sequences f_i produced for the various TrCHs of the communication ($1 \leq i \leq X$) are multiplexed, that is to say placed one after the other, by a module 28 forming a sequence s of S symbols for the CCTrCH. In the case

30   where the periods devoted to the various TrCHs of the communication have variable positions, it may be necessary to append to the sequence s, by means of the module 29, one or more marked symbols "δ". In the exemplary implementation considered here, each symbol

35   w_k of the sequence w output by the module 29 ($1 \leq k \leq \sum_{j=1}^{Y} U_j$,

with $S \le \sum_{j=1}^{Y} U_j$ and U_j equal to the number of bits per

frame on the DPDCH of physical channel j, which number depends on the spreading factor allocated to the channel) is represented by two bits:

5   - $w_k = (0, s_k)$ if $k \le S$;

       - $w_k = (1, 0)$ if $S < k \le \sum_{j=1}^{Y} U_j$.

The module 30 subsequently chops the sequence w into Y segments of U_1, U_2, ..., U_Y consecutive symbols, and
10 respectively assigns these segments to the Y PhCHs to form a sequence denoted u_j for each PhCH j ($1 \le j \le Y$). The interleaving module 31_j performs a permutation of the sequence u_j, with a view to distributing the symbols, within the current frame, over the Y PhCHs
15 employed by the communication. This interleaving consists in writing the symbols of the sequence u_j successively to the rows of a matrix comprising C2 = 2 × N = 30 columns, in permuting the columns of the matrix, and in then reading the symbols of the matrix
20 column by column to form the sequence, denoted v_j, of U_j symbols.

The module 32_j for mapping the physical channel finally distributes the successive symbols of the sequence v_j
25 into the fields DATA1 and DATA2 of the time slots of the current frame. The module 32_j can translate the information bits with values 0 or 1 into signed bits (± 1), and assign the value 0 to the marked bits "δ". It furthermore supplements the stream r_j addressed to
30 the block 3 by inserting the appropriate signalling bits into the fields PL, TFCI and TPC of the DPCCH.

In accordance with the 3G TS 25.212 specification, if R2 denotes the smallest integer such that R2 × C2 is at
35 least equal to the number U_j of bits of the current frame ($U_j \le R2 \times C2$), the permutation of the columns

performed by the intra-frame interleaver 31_j is such that the n-th symbol $u_{j,n}$ of the current frame, with $n = (\alpha-1) \cdot C2 + \beta$, α and β being integers such that $1 \le \alpha \le R2$ and $1 \le \beta \le C2 = 2 \times N$, lies in the $(\varepsilon.R2+\alpha)$-th position in a γ-th time slot of the frame, i.e.

$$u_{j,n} = v_{j,n'}$$

with $n' = 2.(\gamma-1).R2+\varepsilon.R2 + \alpha$ (2)

where $\varepsilon = 0$ or 1 and $2.(\gamma-1) + \varepsilon$ is an integer obtained as a function of $\beta-1$ through a determined permutation $perm_{C2}$ on the integers lying between 0 and $C2-1$:
$2.(\gamma-1) + \varepsilon = perm_{C2}(\beta-1)$.

The demultiplexing block 8 of the terminal comprises modules which perform, in the reverse direction, the operations which are dual to those of the modules 20_i-32_j of the multiplexing block 2 of the base station. In figure 5, the primed references correspond to the estimates of the symbols bearing the same unprimed references in figure 4. For the symbols composed of two bits formatted as indicated hereinabove by reason of the marking of the bits "δ", these estimates (softbits) refer to the least significant bit.

For each 10 ms frame and each PhCH, the module 52_j extracts the sequence v'_j of U_j softbits pertaining to the DPDCH from the fields DATA1 and DATA2 of the demodulated signal. The deinterleaving module 51_j applies the inverse permutation to that of the module 31_j to this sequence v'_j so as to restore the sequence of softbits u'_j. The Y sequences u'_j are placed end to end by the multiplexing module 50 so as to form the sequence of softbits w' which relates to the CCTrCH. In the case where the TrCHs have variable positions, the module 49 deletes the last $\sum_{j=1}^{Y} U_j - S$ softbits of the sequence w', which correspond to "δ" bits. The softbit

sequence s' produced by the module 49 is chopped by the
segmentation module 49 into X subsequences f'_i
respectively assigned to the TrCHs.

5   For each TrCH i whose TTI comprises several frames (F_i
> 1), the module 47_i concatenates the subsequences
produced in relation to the various frames so as to
form the sequence q'_i subjected to the inter-frame
deinterleaving module 46_i. The latter carries out the
10   permutation inverse to that of the module 26_i so as to
restore the sequence of softbits h'_i. In the case where
the TrCHs have fixed positions, the module 45_i deletes
the $F_i.H_i - G_i$ last softbits of the sequence h'_i, which
correspond to "δ" bits. The sequence of softbits s'
15   produced by the module 49 is then processed by the bit
rate matching module 44_i which performs the following
operations:

- insertion of a null softbit (minimum
  likelihood) in place of each bit which has been
20   punctured on transmission;
- reevaluation of each softbit corresponding to a
  bit which has been repeated on transmission, so
  as to sharpen the likelihood thereof.

25   The output sequence c'_i of the module 44_i is decoded by
the module 43_i so as to correct any transmission
errors. The symbols of the decoded blocks o'_i output by
the module 43_i can be softbits, or hardbits if the
likelihood measures are no longer required in the
30   subsequent processings. On the basis of these blocks
o'_i, the module 42_i reconstructs the estimated TrBk b'_i,
and the module 41_i verifies the integrity of the CRC so
as to validate these TrBk in the output stream a'_i
relating to TrCH i.

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Henceforth, we deal with a particular non-restrictive
embodiment of the invention related to the HSDPA ("High
Speed Downlink Packet Access") functionality. An
overall description of this functionality can be found

in TS 25.308 technical specification, Release 5, version 5.0.0, published in September 2001 by the 3GPP.

5   The HSDPA allows the transmission by a base station of data at high bit rate for a set of mobile stations situated in the zone of coverage of the base station. It relies on a high bit rate shared transport down channel: the HS-DSCH ("High speed - Downlink Shared Channel"). In the FDD mode with which the present

10 description is more particularly concerned, this channel has in particular as characteristics: (i) a transmission time interval (TTI) of 2 milliseconds corresponding to 3 time slots of 666 µs; (ii) HARQ ("Hybrid Automatic Repeat reQuest") type data

15 retransmission request hybrid processes; and (iii) an adaptive coding and modulation mechanism. At the access level network, a specific layer of the Medium Access Control (MAC) protocol is located in the base station. Thus, one arranges to offer a maximum bit rate on this

20 channel. For the same reason, the HS-DSCH uses a relatively low spreading factor, equal to 16. In a given cell and for a given scrambling code, it is possible for up to 15 HS-DSCH channels to be set up using orthogonal "channelization" codes.

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For an HS-DSCH channel, there must be provision for one or more specific shared physical control channels called HS-SCCH ("High Speed - Shared Control CHannel") or SCCH-HS. The signaling information carried by the

30 HS-SCCHs identifies the destination terminals from the blocks transmitted on the HS-DSCHs, and provide them with a certain number of indications useful for the reception of these blocks:

        - a Transport Format and Resource Indicator
35   (TFRI) giving the information relating to the
            format of the dynamic part of the HS-DSCH
            channel, in particular for the modulation
            scheme employed, and the physical resources
            allocated ("channelization" codes);

- the information related to the HARQ protocol,
  in particular the redundancy version, an HARQ
  process identifier, and a new data blocks
  indicator.

5

An HS-SCCH channel uses a spreading factor of 128, with
a TTI identical to that of the HS-DSCH (3 slots of
666 µs). All the HS-PDSCHs (that is to say the physical
channels arising from the HS-DSCHs) within a cell are
10 aligned timewise and the synchronization of the
HS-SCCHs is advanced by two slots (1333 µs) with
respect to that of the associated HS-PDSCHs, thereby
allowing the destination terminal for a data block
transmitted on an HS-PDSCH in an HSDPA TTI of 2 ms to
15 know the information necessary for its receipt. Certain
information contained in the TFRI, namely the allocated
codes as well as the modulation used, are paramount for
the terminals since it allows them to start
demodulating the HS-PDSCH(s) relating to them. This is
20 why this information of the TFRI is included in the
first slot of each TTI on the HS-SCCH. Thus, a fast
decoding of the HS-SCCH allows a terminal to read the
content of the HS-PDSCH in the next TTI without loss of
information.

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The feedback information returned by the terminal, in
particular for the acknowledgements of the HARQ
protocol and for the measurements useful for the
adaptive modulation, are transmitted by a dedicated up
30 resource, on a channel dubbed DPCCH-HS ("Dedicated
Physical Control Channel - High Speed").

On setting up the HS-DSCHs and HS-SCCHs, the Radio
Network Controller (RNC) which supervises the base
35 station (CRNC, "Controlling RNC") allocates it the
corresponding code resources, per cell. By way of
example, provision may be made to reserve a list of
L = 16 codes with spreading factor 128 for the
HS-SCCHs.

According to the invention, when an HSDPA session is
open (or reconfigured) for a given terminal, the CRNC
tells it the list of HS-SCCH codes, L of them,
5   allocated to the base station. This list is composed of
several sets of K codes. This subdivision into sets of
K codes can be imposed directly by the CRNC on the base
station or form the subject of a negotiation between
them through the so-called *Iub* interface standardized
10 by the 3GPP.

To address HS-SCCH data blocks to a given terminal, the
base station firstly selects a set of K codes and
indicates same to the terminal. It then selects one of
15 the K codes of this set as a function of the
availabilities on the HS-SCCH TTI concerned. The number
K of HS-SCCH codes per set is, for example, between 1
and 4 for each terminal. Hereinbelow it will be
considered to be equal to 4, without restricting the
20 generality of the account.

In a typical embodiment, a terminal continuously
despreads the signal received by means of the K = 4
HS-SCCH codes that have been indicated to it. However,
25 to avoid needlessly invoking the resources of the
terminal, it is judicious for the latter to decode only
the HS-SCCH with which it is concerned, as appropriate.
To do this, a specific signaling is provided on the
down path, borrowing a dedicated channel (DPCH)
30 operating in parallel with the HS-PDSCH for this
terminal.

This specific signaling comprises a two-bit indicator
called HI ("HS-DSCH Indicator"), carried by the DPCH
35 and indicating to the terminal that information is
destined for it on an identified HS-SCCH. The two bits
of the HI define four states which make it possible to
distinguish which of the four HS-SCCHs is carrying as
appropriate the item of information relating to the

terminal. If the HI is transmitted with zero power (this constituting a fifth state), none of the four HS-SCCHs is carrying any information relating to the terminal. In the latter case, a value may be allocated to the HI by the terminal which leads the latter to decode an HS-SCCH for nothing, but it becomes aware of this quickly since the HS-SCCH also indicates the destination terminal.

The HI destined for a terminal must be transmitted, read and interpreted by this terminal before the end of the first slot of the HS-SCCH, so that it is furnished in time with the information of the TFRI (HS-DSCH code allocated and modulation used) which are necessary to be able to demodulate an HS-PDSCH as appropriate.

A problem posed by the insertion of the HI into the stream transmitted on the DPCH is that its transmission rate is high and that its recovery by the terminal must be very fast. It is necessary to provide 5 transmissions per frame, i.e. $5 \times F_i$ transmissions per TTI of a dedicated transport channel corresponding to this DPCH, and the terminal cannot wait to have received a complete TTI to be decoded before knowing the values of these HIs. Consequently, the HI must be inserted for example after puncturing, or stealing, of QPSK symbols downstream of the second interleaver 30_j. Thus, the two bits of an HI form a QPSK symbol substituted, at the input of the modulator, for a symbol of the sequence to be transmitted. This substitution takes place in only some slots of the frame.

Returning to figure 2, a function of the module 100 is to manage the HSDPA functionality in the base station. In particular, it integrates the instance of the MAC protocol useful for the supervision of the HSDPA mode. This module controls the time-division multiplexing of the transport streams for the HS-DSCH channels of the

cell, which is carried out, at a rate of one stream per
terminal and per TTI on a given code, on the basis of
the information streams received from the RNC by the
multiplexing module 102 represented in figure 2. The
5   signals sent on the corresponding physical channel or
channels HS-PDSCH are spread and modulated in the block
3, by applying as appropriate the specified adaptive
modulation scheme (modules 103), then combined by the
module 84 with those of the other physical channels so
10   as to be transmitted to the radio stage 4 and sent on
the radio path, as explained previously.

The HSDPA management module 100 takes account of the
feedback information UL returned by the terminals on
15   the up path to organize the scheduling of the HARQ
blocks and the adaptation of the modulation for each
TTI of the HS-DSCH. The module 100 furthermore controls
the   transmission   on   the   HS-SCCH   channels.   The
corresponding signals are coded by the modules 105 on
20   the basis of the information specified by the module
100   (identification   of   the   terminals,   TFRI,   HARQ
information,   etc.).   These   signals   are   spread   and
modulated in the block 3 (modules 106), then combined
by the module 84 with those of the other physical
25   channels.

The   HSDPA   management   module   100   also   controls   the
transmission of the HI by stealing symbols on the QPSK
symbol streams provided to the modulators of the DPCHs,
30   before the latter are modulated in the block 3. The HI
is   inserted   by   means   of   a   multiplexer   108   placed
downstream   of   the   multiplexing   block   2,   described
previously with reference to figure 4, on the symbol
stream relating to a PhCH used by the terminal.
35

For each user for which an HSDPA block is destined, the
module 100 selects:
(1)   one   or   more   HS-PDSCH   codes   and   a   TTI   shortly
        available on this code to receive the block;

(2)   an HS-SCCH code, out of the K = 4 possible codes
       for the user, having a TTI available two slots
       ahead of the TTI of the HS-PDSCH channels and
       hence in particular of that selected in step (1).

5

The module 100 then determines the information to be
transmitted in the TTI available on the chosen HS-SCCH,
and instructs the corresponding module 105 accordingly.
Finally, it positions the HI as a function of the

10   HS-SCCH code selected in step (2) and has this HI
inserted into the symbols transmitted on the dedicated
channel, with just enough lead in advance of the TTI of
the HS-SCCH channel (for example at most one slot
ahead).

15

The lower part of figure 3 shows the inverse operations
performed in a receiver terminal. At the output of the
demodulator 92 operating on the PhCH on which the HI is
inserted, a demultiplexer 110 extracts the QPSK symbol

20   corresponding to the HI at the appropriate instants and
supplies it to an evaluation module 111. The latter
instructs, as a function of the value of HI, a selector
112 so as to select one of the K = 4 output streams
from the despreading modules 94 of the block 7, to

25   which the codes of the four HS-SCCHs usable for the
terminal were allocated. Only the stream selected is
then demodulated and decoded by the module 113 so as to
obtain the signaling information transported by the
HS-SCCH. This signaling information is supplied to a

30   module 115 for managing the HSDPA mode in the terminal,
which deduces therefrom the parameters necessary for
the operation:
-      of the block 7 despreading module or modules 95 to
       which the HS-DSCH codes signaled on the HS-SCCH
35 ·   are allocated;
-      of the demodulation and decoding module 116 which
       receives the corresponding stream of despread
       symbols and which applies the appropriate

reception processing by supplying the feedback
information required (acknowledgement, etc.).

The HSDPA management module 115 formulates the UL
5   signals to be returned on the up DPCCH to the base
station of the cell on the basis of the feedback
information obtained by the module 116. It also
indicates to the despreading modules 94 which is the
set of K = 4 HS-SCCH codes usable among the list of L
10 codes which was indicated to it by the Serving RNC
(SRNC) for the setting up of the HSDPA session. This
SRNC is often merged with the CRNC supervising the base
station. It may, however, also be a separate RNC,
communicating with the CRNC through the so-called *Iur*
15 interface standardized by the 3GPP.

A stealing of bits at a fixed position every three
slots so as to insert therein the symbol containing the
HI may pose a problem of degradation of the signal
20 carried by the DPCH channel after decoding by the
terminal. The two deinterleaving steps 51_j, 46_i
performed in the terminal modify the position of the
symbols r'_j received in such a way that bits that are
far apart in the slots transmitted may be clustered
25 together after deinterleaving. This clustering means
that there is a risk of having punctured several
consecutive information bits (up to 4 bits), and
therefore entails significant degradation of the
performance of the channel decoding 43_i.
30

Figure 6 shows an example of a transport block 60
containing 294 bits, denoted A_1, A_2, A_3, ..., A_{294}, after
channel coding 23_i and bit rate adaptation 24_i. In
accordance with what was described earlier, the
35 interleaving module 26_i in the base station performs an
interleaving operation on this transport block 60. It
amounts to writing row-wise in a two-column matrix 61
the sequence of bits of the transport block 60. The
choice of the number of columns (two in the present

case) is dependent on the TTI of the transport block 60. In the example set forth, a TTI of 20 milliseconds is considered, so that the transport block 60 will be divided into two when the stream of bits transmitted is

5   put into frames (F_i = 2). The interleaving carried out by the module 26_i then consists in reading the initial sequence of bits in the order of the columns of the matrix 61, beginning with the second column.

10   During the segmentation of the radio frames performed by the module 27_i, frames 62 such as represented in figure 6 are thus obtained. The first frame of the TTI contains the odd bits of the initial sequence of bits of the transport block 60, whereas the second frame

15   contains the even bits of this sequence of bits. It is therefore apparent in this figure that bits that are initially neighbors of the sequence contained in the block 60, such as A_1 and A_2, are located, after segmentation into frames, at identical positions in

20   each of the two frames constructed. Thereafter, the permutation applied by the second interleaver 31_j is the same for each frame (independently of the details of this permutation), so that the two consecutive symbols A_1, A_2 will again be located at identical

25   positions after this second interleaver 31_j (frames 63 in figure 6): they will then form part of QPSK symbols of like rank in two consecutive radio frames. If the QPSK symbol having this rank is lost on account of the insertion of an HI into the first frame, it will be

30   likewise for that having the same rank in the next frame by reason of the puncturing performed at a fixed position 15 slots later, i.e. with a 5 TTI shift of the HS-SCCH. It is then seen that neither of the two consecutive symbols A_1, A_2 will be received by the

35   terminal, thereby decreasing the performance of the decoder.

Figure 6 therefore shows that, when F_i > 1, the characteristics of the first interleaver 26_i are such

that the substitution of the HI at fixed positions in
the slots degrades the reception of the information on
the dedicated channel.

5   Figure 7 actually illustrates the structure of the
second interleaver 31_j. Figure 7 presents a frame 70 to
be sent on a DPCH channel, which frame consists of
information bits after multiplexing of the transport
channels (and segmentation by PhCH if Y > 1). This
10   frame 70 is composed of several groups of bits,
respectively arising from different transport channels
(TrCH), concatenated by the module 28 of figure 4.
These TrCHs correspond, for example, to categories of
bits of variable significance, arising from a speech
15   coder of AMR ("Adaptive Multi-Rate") type. It is thus
possible to distinguish a first group of bits a_1, a_2,
a_3, ..., a_m pertaining to a TrCH A, a second b_1, b_2, b_3,
..., b_n pertaining to a TrCH B, a third group of bits
c_1, c_2, c_3, ..., c_p pertaining to a TrCH C, and a fourth
20   group of bits d_1, d_2, d_3, ..., d_q pertaining to a TrCH
D. The succession of these groups of bits results from
the multiplexing of the transport channels by the
module 28 within a frame of 10 milliseconds.

25   The intra-frame interleaving performed by the module
31_j amounts to writing the bits of the frame 70 row-
wise into a matrix 71 of C2 = 30 columns. The module
31_j thereafter reads the matrix 71, column by column,
after permuting the 30 columns of this matrix. The
30   resulting stream of bits is thereafter positioned in
the slots to be transmitted on the physical channels,
at a rate of two bits per QPSK symbol. Since the number
of columns of the matrix 71 (C2 = 30) is twice the
number of slots per frame (N = 15), the symbols of a
35   slot correspond to two adjacent columns of the matrix
after permuting the columns. The lower part of figure 7
shows the content of the first seven slots 72 of the
frame in a case where there are m = 62 bits in TrCH A.
If a QPSK symbol of like position is punctured every

three slots (for example the first symbol corresponding
to the first two bits encircled in the lower part of
figure 7), it may be seen that we almost always fall
within the bits arising from the same TrCH, namely TrCH
5   A in the example drawn, of which bits a_1, a_{31}, a_4, a_{34},
a_2, a_{32}, a_5, a_{35}, a_{13}, a_{43} will be lost.

Figure 7 therefore shows that the slots thus
constructed do not allow random distribution of the
10 bits as a function of their TrCH of origin. This
results in a considerable misbalance of processing
between the TrCHs, which can only degrade the quality
of service.

15 Moreover, in the TrCH(s) thus disadvantaged, the
probability of puncturing two neighboring bits in the
output stream from the channel coder 23_i is increased.
This negative effect is accentuated by that highlighted
by the illustration of figure 6 when there are several
20 frames in the TTI.

To alleviate these drawbacks, the position of the
punctured symbols replaced by HIs is varied from one
slot to another. This results in:
25 -   a better share-out of the punctured bits between
        the TrCHs when the PhCH comprises contributions
        from several TrCHs (cf. figure 7);
     -    a better share-out of the punctured bits in the
        output stream from the channel coder 23_i when
30   there are several frames per TTI, that is to say
        when $F_i > 1$ (cf. figure 6).

A great number of choices of variable position of the
symbols stolen in the frames and the slots may be made
35 so as to comply with these criteria. For example, a
circular permutation of the positions of the stolen
symbols is performed on certain slots of each frame.
Stated otherwise, the positions of five stolen symbols
are the same from one frame to another, but are not

applied to the same slots. In another example, the
position of the stolen symbols is no longer preserved
from one frame to another, but is translated by one
symbol for each frame.

5

To signal to the terminal the set of K = 4 HS-SCCH
codes that the base station has selected for it, the
latter also uses the dedicated channel. Nevertheless,
this signaling information does not generally need to
10   be updated as quickly as the HI.

By way of example, a modification of the selected set
of K = 4 HS-SCCH codes for a terminal may be made
within the context of a reconfiguration of the
15   internal, hardware and/or software, resources of the
base station, in particular when the latter has a
modular architecture.

Figure 8 illustrates an exemplary hardware architecture
20   of the base station. This architecture is modular as
far as the digital processing carried out in the
communication channels is concerned, in particular the
coding and the multiplexing of the channels. In this
example, the base station is composed of:
25   -   several modules 200 for digital processing of
information streams (three modules in the example
drawn), one of the main roles of which, for the
dedicated channels, is to ensure the coding and
the multiplexing of the transport stream and the
30   shaping of the physical channels in the manner
explained with reference to figure 4. Another role
is to perform the spreading of the signals by the
"channelization" and scrambling codes. For the up
channels, the module 200 carries out the inverse
35   processing of despreading, demodulation,
demultiplexing and decoding;
     -      one or more radio processing modules 201 (two
modules in the example drawn) which shape the
signals arising from the digital processing

modules 200 and transpose them onto the carrier
frequency, ensuring the radio processing required
in order to feed one or more antennas. In the up
direction, the module 201 carries out the inverse

5   processing of filtering, transposition and
digitization;

-       a module 202 for interfacing with the CRNC which
supervises the base station. This module 202
operates in accordance with the *Iub* interface;

10   -   a switching platform 203 which steers the data
streams between the modules 200, 201 and 202;

-       a task manager 204, conversing with the other
modules through the switching platform 203, a main
role of which is to share out all the processing

15   to be performed between the various modules of the
base station. The digital processing modules 200
are in particular assigned the transport channels,
and the corresponding physical channels, with
which they have to deal, by this task manager 204.

20

For the HSPDA functionality, one or more of the digital
processing modules 200 must comprise the facilities
100-108 illustrated by figure 2, in particular the MAC
instance (which may nevertheless be executed in part in

25   the manager 204). Such a module 200 will therefore be
assigned one or more HS-PDSCH codes and associated
HS-SCCH codes by the manager 204. These HS-SCCH codes
typically correspond to one of the sets of K codes from
the list of L codes which was allocated to the base

30   station by its CRNC. The HSDPA manager 100 of this
module 200 will therefore make its selection of the
HS-SCCH code, indicated by the HI, from among the set
of K codes that has been assigned to this module 200.

35   In order to optimize the operation of the base station,
it is desirable for the dedicated channel used to
transmit the HI to a given terminal not to be processed
by a different module 200 from that which carries out
the HSDPA processing for this terminal (HS-SCCH and

HS-DSCH). The same observation applies to the DPCCH-HS
dedicated channel through which the terminal uploads
the feedback information. Not taking this precaution
leads to needless loading of the interfaces between the
5   switching platform 203 and the modules 200 for
exchanging information very quickly between various
modules 200. More generally, it is preferable for all
the channels relating to a given terminal to be
processed by the same module 200. This makes it
10   possible to reduce the processing times and the
problems related to the synchronization of these
processing operations.

In the illustration of figure 8, the digital processing
15   modules 200 are hardware modules, consisting for
example of one or more electronic cards each. It will
be noted that the same problems arise if dealing with
software modules, the interfaces that one wishes to
avoid overloading then being software interfaces
20   between processes.

To optimize the use of the processing resources in the
base station, the manager 204 may therefore be induced
to reassign the resources used for a given terminal,
25   and in particular to toggle this terminal from one
module 200 to another. This results in a transfer of
the HSDPA MAC instance to another module 200 and in a
modification of the HS-SCCH and HS-DSCH codes that will
be used for the terminal. The modification of the
30   HS-DSCH codes poses no problem since the latter are
indicated explicitly in the TFRI transmitted on the
HS-SCCH. On the other hand, the base station must
inform the terminal of the modification of the set of K
HS-SCCH codes.
35

Such a reassignment of the processing resources of the
base station may be initiated by the task manager 204
as a function of the evolution of the load in the cell
served, for example if the terminal concerned (or

another terminal processed by the same module 200)
needs extra resources that are no longer available in
this module. In general, it will not be necessary to
advise the CRNC or the SRNC of these channel
5   reassignments.

The base station is initially informed by way of the
Iub interface, by means of the NBAP protocol ("Node B
Application Part", see technical specification 3GPP TS
10 25.433, Version 4.2.0, Release 4, published in
September 2001), of the list of L = 16 HS-SCCH channels
that is allocated to it by the CRNC. On setup of the
HSDPA session with the terminal, the SRNC indicates
this list to the terminal (that it has obtained through
15 the *Iur* interface if it is not merged with the CRNC),
by means of the RRC protocol ("Radio Resource Control",
see technical specification 3GPP TS 25.331,
Version 4.2.1, Release 4, published in September 2001).

20 The indication of the set of K HS-SCCH channels to be
taken into account by the terminal can a priori be
effected at any moment determined by the base station.
Here, the assumption is made that it is effected
periodically. In this case, the new HS-SCCH channels
25 may be used right from the next period of updating of
this indication, which is here dubbed the period T. The
period T in question depends on the periodicity with
which one wishes to be able to perform the modification
of the resources. It should be a multiple of three time
30 slots of 666 μs, so as to be synchronized with the TTI
of the HS-DSCHs and of the HS-SCCHs. In general, the
management of the hardware and/or software resources of
the base station does not require overly frequent
modifications, so that it is not necessary to perform
35 such a change and, hence, to indicate all the three
time slots to the terminal.

By way of example, this period T may be fixed at 80 ms.
The indication made to the terminal can request a

simple transmission of the information during this
period, this corresponding to the transmission of a
small number of symbols, or else, preferably, a
redundant transmission of this information, thereby
5   increasing the number of information-carrying symbols
that will be transmitted to the terminal during the
period T. Examples of such coding will be described
later.

10   During the current period T, the HSDPA manager 100 of
the module 200 processing the channels associated with
the terminal inserts an HSI indication of the HS-SCCH
channels that will be used during the next period T. In
the absence of reconfiguration of the resources of the
15   base station, this indication designates the set of
K = 4 HS-SCCH codes managed in this module 200. In the
presence of a reconfiguration of the resources leading
to the terminal being transferred to another module 200
of the base station, this indication designates the set
20   of K = 4 HS-SCCH codes managed in this other module.

In our particular case where K = 4 and L = 16, the HSI
indication may pertain to two bits. To take account of
a certain number of possible typical cases, provision
25   may be made for this indication to be represented on
more bits, for example 5 bits.

The particular case where L = 16 with disjoint sets of
K = 4 channels is merely an illustration of the
30   invention. In practice, the sets making up the list of
shared channels that is allocated to the base station
may have the same number of channels K or numbers of
channels that differ. They may also exhibit overlaps,
certain codes of the list possibly belonging to several
35   of these sets.

It will be observed that the method according to the
invention can be applied to a control of shared
communication channels used by a base station whose

architecture is not necessarily modular. Other considerations may in fact cause one to search for the flexibility of channel management that affords the base station the ability to select the HS-SCCH codes
5   assigned to a given terminal without being constrained by an allocation that the RNC would have made specially for this terminal. For example, it is conceivable to imagine that the list of HS-SCCH channels that is allocated to a base station should comprise several
10 sets of channels having different spreading factors and that the base station should select one of these sets by taking account of the power control bits uploaded by the terminal to slave the transmission power to the HS-SCCH: if a high or low threshold of power is
15 attained on the HS-SCCH, the base station could choose to vary the spreading factor on the next period T, and hence to change the set of HS-SCCH codes in the list which is allocated to it, without having to refer same to the CRNC or to the SRNC. The HSI makes it possible
20 to signal such changes to the terminal.

In a first embodiment of the invention, the insertion of the HSI indication is performed by a symbol stealing mechanism similar to that described earlier in respect
25 of the insertion of the HI, preferably after application of a redundant coding to this HSI indication.

The HSDPA manager 100 then supplies the symbols
30 corresponding to the HSI, which the multiplexer 108 substitutes for determined symbols (figure 2) delivered by the multiplexing module 2 for a DPCH destined for the terminal. At the terminal level (figure 3), the demultiplexer 110 extracts from the stream of
35 demodulated symbols received on this DPCH the symbols which correspond to the HSI and addresses them to an evaluation unit 120. The latter decodes the symbols extracted in the course of the period T, correcting any transmission errors, so as to recover the HSI addressed

to the HSDPA manager 115, which assigns the
corresponding codes to the despreading modules 94 for
the next period T.

5   It should be noted that the HSI indication can be
transmitted with or without the HI indication discussed
previously. It is conceivable not to transmit the HI if
the terminals can decode the K = 4 HS-SCCH channels
indicated by the HSI without this overly penalizing
10   their electrical consumption. QSPK symbols can then be
stolen on the DPCH so as to transmit the HSI rather
than the HI.

If the HI is used, the positions of the symbols stolen,
15   so as to insert therein the HSI the next period T, must
take account of the position of the symbols stolen so
as to insert therein the HI, so as to avoid degrading
the performance of the transmission channel on account
of the effect of the two interleavers, as explained
20   with reference to figures 6 and 7.

Figure 9 shows an example of a function for
distributing the stolen symbols in the case of a TTI of
40 ms (F_i = 4) on the DPCH, the HI forming the subject
25   of a theft of five QPSK symbols per frame, and the HSI
forming the subject of a theft of one QPSK symbol per
frame. It represents a table indicating, for the four
frames indexed from 0 to 3, the index number of the
QPSK symbols stolen in each slot transmitted by the
30   base station. The stolen symbols for the HI in the
first frame have respectively the positions 0, 3, 6, 9
and 12 in the slots numbered 0, 3, 6, 9 and 12. This
prevents the problem mentioned above with reference to
figure 7 in relation to the misbalance in the
35   processing of the multiplexed TrCHs. For the next
frame, a circular permutation is applied to these
symbol positions, so that the symbols of positions 3,
6, 9, 12 and 0 are respectively stolen from slots
numbered 0, 3, 6, 9 and 12. The same circular

permutation is applied to determine the positions of
theft from the following frames. This circular
permutation prevents the problem eluded to above with
reference to figure 6 in relation to the degradation in
5   performance of the channel decoder due to the first
interleaver when $F_i > 1$. In the intermediate slots
numbered 1, 2, 4, 5, 7, 8, 10, 11, 13 and 14, no QPSK
symbol is stolen in this example. The position of the
stolen symbols follows the same scheme as for the first
10 four frames represented, for the next four frames. The
HSI indication requires the stealing of one QPSK symbol
per frame, which corresponds to 16 bits per 80 ms
period T.

15 In the example of figure 9, the positions chosen for
the stolen symbols have respectively index numbers 13,
1, 4 and 7 in slot 0 of each frame. The index numbers
of these positions have been primed in the figure so as
to distinguish them from the symbols stolen for the HI.
20 The position of the stolen symbols follows the same
scheme as for the first four frames represented, for
the next four frames. Thus, all the symbols stolen,
whether for the HI or for the HSI, have different
positions for one and the same slot in successive
25 frames, thereby preventing the problem of the first
interleaver set forth above. Furthermore, the positions
of all the stolen symbols vary likewise from one slot
to the next in one and the same frame, so that one is
forearmed against the negative effects of the second
30 interleaver.

As a variant, the symbols stolen for the HSI are in a
time slot of the frame which has not formed the subject
of a symbol stealing for the HI, for example in slot 1
35 in the illustration of figure 9.

The same pattern of the positions of substitution of
the symbols representing the HSI may be applied if the
HI is not transmitted.

Preferably, the QPSK symbols corresponding to the HSI
and/or to the HI, are sent by the base station with a
greater transmission power than the other information
5   symbols. In this case, the destination terminal can
read these symbols reliably before decoding the
information streams received, while limiting the risk
of error. However, the increase in the power for these
symbols is not indispensable, especially in the case
10   where the HSI is transmitted with a redundant coding.

Various codings of the HSI information are conceivable
and result in a greater or lesser number of symbols to
be stolen in the symbol stream carried by the DPCH
15   channel dedicated to the terminal. It is conceivable to
transmit the indication in a raw manner, that is to say
without redundancy. In this case, a small number of
symbols is sufficient for a period T.

20   Preferably, the HSI is coded in such a way as to make
its reception by the terminal reliable.

In a particular embodiment, the HSI indication may be
represented by 5 bits before coding, and this item of
25   information is coded in such a way that it forms the
subject of one symbol per radio frame over a period T
of 80 ms. In this case, the number of bits to be stolen
on the stream of the DPCH corresponding to the period T
is 16 (= 8 frames × 2 bits for a QPSK symbol). A
30   possible coding is the bi-orthogonal coding (16,5)
described in Section 4.3.3 of the aforementioned
technical specification 3G TS 25.212. A theft of 16
bits is therefore carried out according to this coding
by the base station, for example in the positions
35   illustrated in figure 9. The evaluation module 120 of
the terminal decodes the 16 information-carrying bits
and deduces therefrom the HSI designating the set of
HS-SCCH selected, that it may possibly have to read at
the next period T.

The same coding can be used for the HSI by stealing two QPSK symbols per radio frame over a period T of 40 ms, which corresponds to 16 bits (= 4 frames × 2 × 2 bits
5   per QPSK symbol), with or without additional stealing for the HI.

If one wishes to transmit the HSI at a rate of two symbols per frame over a period T of 80 ms, it is
10 possible to use a coding of the item of information on 32 bits (= 8 frames × 2 × 2 bits per QPSK symbol). The bi-orthogonal coding (32,10) described in Section 4.3.3 of the aforementioned technical specification 3G TS 25.212 may meet this need.
15

If the HI is not transmitted, it is also conceivable to code the HSI at a rate of one symbol per HSDPA TTI (TTI of the HS-DSCH and of the HS-SCCHs), that is to say every 2 ms. For a frame, this corresponds to a total of
20 10 bits (= 10/2 × 2 bits per QPSK symbol). If the HSI before coding requires only 3 bits, it is possible to use a (10,3) coding, such as for example that described in the technical report 3G TR 25.870, Version 1.1.0, published in November 2001 by the 3GPP. By way of
25 example, the positions of the 5 QPSK symbols stolen in a frame may be those indicated for the HI in figure 9.

When the HI is transmitted, it should be taken into account during the symbol stealing carried out on the
30 DPCH concerned to transmit the HSI. Having regard to the small stealing period for the HI (one symbol per HSDPA TTI, i.e. 2 bits every 2 ms), the coding of the HSI is preferably done on a small number of bits. It can, for example, be transmitted by stealing one symbol
35 every 2 radio frames over a period T of 80 ms, which corresponds to 8 (= 80/(10 × 2) × 2) stolen bits over a period of 80 ms. For this purpose and if the HSI requires only 2 bits before coding, it is possible to use a (7,2) coding such as described in the afore-

mentioned technical report 3G TR 25.870, and one
repeating one of the seven coded bits.

The aforementioned (16,5) coding within the context of
5   a stealing of one symbol per frame over a period of
80 ms may also be used for the HSI advantageously in
the presence of the HI, since the period of such
stealing is small enough not to significantly degrade
the performance of the reception chain.
10

The example may also be cited of a stealing of one
symbol every two HSDPA TTIs for the HSI in the presence
of the HI. This corresponds to a stealing of 20 bits
over a period T of 40 ms (i.e. $40/(2 \times 2) \times 2$). In this
15   case, a (10,3) coding such as eluded to above may be
used, each coded bit being repeated once. For a period
T of 80 ms, the same (10,3) coding is suitable, each
coded bit being repeated three times.

20   In a second embodiment of the invention, the insertion·
of the HSI indication onto the dedicated down channel
is performed through the intermediary of a specific
coding of a data field present on the DPCCH of this
dedicated channel. This field, is typically that
25   reserved for the transmission of the TFCI. The TFCI is
transmitted to the terminal at the rate of a few bits
per 666 μs slot over the duration of a 10 ms radio
frame, with a redundant coding to protect it against
transmission errors. It is possible to add possible
30   states on input to this coding so as to transmit an
additional item of information. For example, by
doubling the number of states, it is possible to insert
a signaling bit per frame, which can be utilized to
transmit the HSI over a period T of n frames if the HSI
35   is composed of n bits.

This second embodiment of the invention also allows the
transmission of the HSI either alone or accompanied by

an   HI   transmitted   by   the   above   symbol   stealing
mechanism.

Of course, the invention is not limited to the cases of
application described above by way of illustration. The
method   according   to   the   invention   is   moreover
applicable to systems other than HSDPA or UMTS.